ENVIROTHON PRACTICE DAY

AQUATICS GUIDE

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Introduction

This is not the answer to all of the questions. This is a resource guide that will have lots of information about aquatic topics that might be covered in the aquatics portion of the Envirothon test. This information comes from a wide variety of sources including Kentucky Division of Water, US Geologic Survey, US Environmental Protection Agency and a wide assortment of other programs. We hope that this helps in your journey towards understanding aquatics.

Wetland Definition

Generally, wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface (Cowardin, December 1979). Wetlands vary widely because of regional and local differences in soils, topography, climate, hydrology, water chemistry, vegetation, and other factors, including human disturbance. Indeed, wetlands are found from the tundra to the tropics and on every continent except Antarctica.

For regulatory purposes under the Clean Water Act, the term wetlands means "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas."

Habitat Assessment

From KY DOW Sampling SOP

The visual-based habitat evaluation consists of ten parameters that rate instream habitat, channel morphology, bank stability and riparian vegetation for each sampling reach. A numerical scale of 0 (lowest) to 20 (highest) is used to rate each parameter (Barbour et al. 1999). For each parameter, the investigators will determine which of the following conditions exist at the sampling reach: Optimal, Suboptimal, Marginal or Poor. A parameter score will then be given within the condition category chosen above: Optimal (20-16), Suboptimal (15-11), Marginal (10-6) or Poor (5-0). The investigators will total all of the parameter ratings to obtain a final habitat ranking (Barbour et al. 1999).

I. PARAMETERS FOR HABITAT ASSESSMENT

i. These parameters should be evaluated within the sampling reach. All of the areas within the reach should be evaluated together as a composite.

Parameter #1

<u>Epifaunal Substrate/Available Cover</u> - this metric measures the relative quantity and the variety of structures: cobble, boulders, fallen trees, logs, branches, root mats, undercut banks, aquatic vegetation, etc., that provide refugia, feeding opportunities and sites for spawning and nursery functions.

1. <u>Optimal</u>: >70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient) (20-16)
2. <u>Suboptimal</u>: 40%-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at the high end of the scale) (15-11)
3. <u>Marginal</u>: 20%-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed (10-6)
4. <u>Poor</u>: <20% stable habitat; lack of habitat is obvious; substrate unstable or lacking (5-0)

Parameter #2

<u>Embeddedness</u> - the extent to which rocks and snags are covered or sunken into the silt, sand, mud or biofilms (algal, fungal or bacterial mats) of the stream bottom. Generally, as rocks become embedded, the surface area available to macroinvertebrates and fish (for shelter, spawning and egg incubation) is decreased; assess in the upstream or central portions of riffles.

a. <u>Optimal</u>: Rocks are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space (20-16)
b. <u>Suboptimal</u>: Rocks are 25%-50% surrounded by fine sediment (15-11)
c. <u>Marginal</u>: Rocks are 50%-75% surrounded by fine sediment (10-6)
d. <u>Poor</u>: Rocks are >75% surrounded by fine sediment (5-0)

Parameter #3

<u>Velocity/Depth Regime</u> - the best streams in most high-gradient regions will have all of the following patterns of velocity and depth: 1) slow-deep, 2) slow-shallow, 3) fast-deep, and 4) fast-shallow; the occurrence of these four patterns relates to the stream's ability to provide and maintain a stable aquatic environment. Investigators may have to scale deep and shallow depending upon the stream size; a general guideline is 0.5 m between shallow and deep.

a. <u>Optimal</u>: All 4 regimes present (20-16)
b. <u>Suboptimal</u>: Only 3 of the 4 regimes present; if fast-shallow is missing, score lower than if missing other regimes (15-11)
c. <u>Marginal</u>: Only 2 of the 4 regimes present; if fast-shallow or slow-shallow are missing, score low (10-6)
d. <u>Poor</u>: Dominated by 1 regime (usually slow-deep) (5-0)

Parameter #4

<u>Sediment Deposition</u> - measures the amount of sediment that has accumulated in pools and changes that have occurred to the stream bottom as a result of deposition. This may cause the formation of islands, point bars (areas of increased deposition usually at the beginning of a meander that increases in size as the channel is diverted toward the outer bank) or shoals or result in the filling of runs and pools. Sediment is often found in areas that are obstructed and areas where the stream flow decreases, such as bends. Deposition is a symptom of an unstable and continually changing environment that becomes unsuitable for many organisms.

1. <u>Optimal</u>: Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition (20-16)
2. <u>Suboptimal</u>: Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5%-30% of the bottom affected; slight deposition in pools (15-11)
3. <u>Marginal</u>: Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30%-50% of the bottom affected; moderate sediment deposits apparent at most obstructions and slow areas, bends and pools (10-6)
4. <u>Poor</u>: Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition (5-0)

Parameter #5

<u>Channel Flow Status</u> - the degree to which the channel is filled with water; will change with seasons.

1. <u>Optimal</u>: Water reaches base of both lower banks; minimal amount of channel substrate exposed (20-16)
2. <u>Suboptimal</u>: Water fills >75% of the available channel; or <25% of channel substrate exposed (15-11)
3. <u>Marginal</u>: Water fills 25%-75% of the available channel; riffle substrates are mostly exposed (10-6)
4. <u>Poor</u>: Very little water in channel; mostly present in pools (5-0)

ii. **The next 5 parameters should evaluate an area from approx. 100-m upstream of the sampling reach through the sampling reach. This whole area should be evaluated as a composite. When determining left and right bank, look downstream.**

Parameter #6

Channel Alteration - measures the large-scale changes in the shape of the stream channel; channel alteration is present when 1) artificial embankments, rip-rap and other forms of bank stabilization or structures are present, 2) the stream is very straight for significant distances, 3) dams and bridges are present and 4) other such changes have occurred.

1. Optimal: Channelization or dredging absent or minimal; stream with normal pattern (20-16)
2. Suboptimal: Some channelization present, usually in areas of bridge abutments; evidence of past channelization (dredging, etc., >20 past years) may be present, but recent channelization not present (15-11)
3. Marginal: Channelization may be extensive; embankments or shoring structures present on both banks; and 40%-80% of the stream reach channelized and disrupted (10-6)
4. Poor: Banks shored with gabion or cement; >80% of the stream disrupted; instream habitat greatly altered or removed entirely (5-0)

Parameter #7

Frequency of Riffles (or Bends) - measures the sequence of riffles and thus the heterogeneity occurring in a stream.

a. Optimal: Occurrence of riffles relatively frequent; ratio of distance between riffles divided by the width of the stream <7:1 (generally 5 to 7); variety of habitat is key; in streams where riffles are continuous, placement of boulders or other large, natural obstruction is important (20-16)
b. Suboptimal: Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 and 15 (15-11)
c. Marginal: Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 and 25 (10-6)
d. Poor: Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is >25 (5-0)

Parameter #8

Bank Stability - measures whether the stream banks are eroded or have the potential to erode. Each bank is scored independently from 10-0.

1. Optimal: Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems; <5% of bank affected (10-9)
2. Suboptimal: Moderately stable; infrequent, small areas of erosion mostly healed over; 5%-30% of the bank affected (8-6)
3. Marginal: Moderately unstable; 30%-60% of bank in reach has areas of erosion; high erosion potential during floods (5-3)
4. Poor: Unstable; many raw, eroded areas; obvious bank sloughing; >60% of bank has erosional scars (2-0)

Parameter #9

Bank Vegetative Protection - measures the amount of vegetative protection afforded to the stream and the near-stream portion of the riparian zone. Each bank is scored independently from 10-0.

1. Optimal: >90% of the streambank surfaces and immediate riparian zones covered by natural vegetation, including trees, understory shrubs, herbs and nonwoody macrophytes; vegetation disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally (10-9)
2. Suboptimal: 70%-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one half of the potential plant stubble height remaining (8-6)
3. Marginal: 50%-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one half of the potential plant stubble height remaining (5-3)
4. Poor: <50% of the streambank surfaces covered by vegetation; disruption is very high; vegetation has been removed to 5 cm or less in average stubble height (2-0)

Parameter #10

Riparian Vegetative Zone Width - measures the width of the natural vegetation from the edge of the streambank through the riparian zone. The presence of old fields, paths, walkways, etc., in otherwise undisturbed riparian zones may be judged to be inconsequential to destruction of the riparian zone. Each bank is scored independently from 10-0.

1. Optimal: Width of riparian zone >18 m; human activities (parking lots, roadbeds, clear-cuts, lawns, pastures or crops) have not impacted the zone (10-9)
2. Suboptimal: Width of riparian zone 13-18 m; human activities have impacted the zone only minimally (8-6)
3. Marginal: Width of riparian zone 6-12 m; human activities have impacted the zone a great deal (5-3)

5. Poor: Width of riparian zone <6 m; little or no riparian zone due to human activities (2-0) (Barbour et al. 1999)

And just for your information:

Substrate Particle Size	
Categories	**Size (mm)**
Boulders	>256 (= 10 in)
Cobble	64 - 256 (= 2.5 - 10 in)
Pebble	16 - 64 (= .63 - 2.5 in)
Gravel	2 - 16 (=.08 - .63 in)
Fines	<2 (= .08 in)
Exposed Bedrock	--
Hardpan Clay	--
Detritus	--

Macroinvertebrate Sampling

1. **Riffle Sample**
   This technique samples the most important subhabitat (i.e., riffle) found in moderate to high-gradient streams. It requires using a 600 μm mesh, one meter wide net in moderate to fast current in areas with gravel to cobble substrate. Four (4) 0.25 m^2 samples are taken from mid-riffle or the thalweg (path of deepest thread of water), dislodging benthos by vigorously disturbing 0.25 m^2 (20 x 20 in.) in front of the net. Large rocks should be hand washed into the net. The contents of the net are then washed and all four samples are composited into a 600 μm mesh wash bucket. ***This sample must be kept separate from all other subhabitat collections.***

2. **Multi-Habitat Sample**
   - **a) Sweep Sample** - This sample involves sampling a variety of non-riffle habitats with the aid of an 800 x 900 μm mesh triangular or D-frame dipnet. Each habitat is sampled in at least three (3) replicates, where possible.
     1) *Undercut banks/root mats* - sampled by placing a large rootwad into the triangular or D-frame dipnet and shaken vigorously. The contents are removed from the dipnet and placed into a mesh wash bucket. Note: if undercut banks are present in both run and pool areas, each is sampled separately with three replicates.
     2) *Marginal emergent vegetation* (exclusive of *Justicia americana* beds) - sampled by thrusting (i.e., "jabbing") the dipnet into the vegetation for ca. 1 m, and then sweeping through the area to collect dislodged organisms. Material is then rinsed in the wash bucket and any sticks, leaves and vegetation are thoroughly washed and inspected before discarding.
     3) *Bedrock or slab-rock habitats* - sampled by placing the edge of the dipnet flush on the substrate, disturbing approximately 0.1 m^2 of area to dislodge attached organisms. Material is emptied into a wash bucket.
     4) *Justicia americana (water willow) beds* - sampled by working the net through a 1 m section in a jabbing motion. The material is then emptied into a wash-bucket and any *J. americana* stems are thoroughly washed, inspected and discarded.
     5) *Leaf Packs* - preferably "conditioned" (i.e., not new-fall material) where possible; samples are taken from a variety of locations (i.e., riffles, runs and pools) and placed into the wash-bucket. The material is thoroughly rinsed to dislodge organisms and then inspected and discarded.

   - **b) Silt, sand, and fine gravel**

     Sieving - a U.S. No. 10 sieve is used to sort out larger invertebrates (e.g., mussels, burrowing mayflies, dragonfly larvae) from silt, sand and fine gravel by scooping the substrate to a depth of ca. 5 cm. A variety of collection sites are sampled in order to obtain 3 replicates in each substrate type (silt, sand and fine gravel).

   - **c) Aufwuchs sample** - small invertebrates associated with this habitat are obtained by washing a small amount of rocks, sticks, leaves, filamentous algae and moss into a medium-sized bucket half filled with water. The material is then elutriated and sieved with the nitex sampler.

d) **Rock Picking -** invertebrates are picked from 15 rocks (large cobble-small boulder size; 5 each from riffle, run and pool). Selected rocks are washed in a bucket half filled with water, then carefully inspected to remove invertebrates with fine-tipped forceps.

e) **Wood Sample -** pieces of submerged wood, adding ranging from roughly 3 to 6 meters (10 to 20 linear feet) and ranging from 5–15 cm (2–6 inches) in diameter, are individually rinsed into the wash-bucket. Pieces of wood are inspected for burrowers and crevice dwellers. Large diameter, well-aged logs should be inspected and hand-picked with fine-tipped forceps.

DEFINITIONS OF SPECIAL USE WATERS

Special use waters are rivers, streams and lakes listed in Kentucky Administrative Regulations or the Federal Register as Cold Water Aquatic Habitat, Exceptional Waters, Reference Reach Waters, Outstanding State Resource Waters, Outstanding National Resource Waters, State Wild Rivers and Federal Wild and Scenic Rivers. Not included as special use waters are waterbodies designated by default as Warm Water Aquatic Habitat, Primary Contact Recreation and Secondary Contact Recreation.

"**Cold water aquatic habitat**" means surface waters and associated substrate that will support indigenous aquatic life or self-sustaining or reproducing trout populations on a year-round basis. (401 KAR 5:031, Section 4).

"**Outstanding state resource waters**" means surface waters designated by the cabinet pursuant to 401 KAR 5:031, Section 7, and includes certain unique waters of the Commonwealth.

"**Exceptional waters**" means waterbodies whose quality exceeds that necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water. (401 KAR 5:030, Section 3).

"**Federal wild river areas**" is a classification of the Wild and Scenic Rivers Act (PL 90-542) and means those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America.

"**Federal scenic river areas”** is a classification of the Wild and Scenic Rivers Act (PL 90-542) and means those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads.

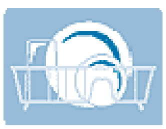
"**Outstanding National Resource Waters**" are waters that meet the requirements for an outstanding state resource water classification and are of national ecological or recreational significance. They are listed in 401 KAR 5:030, Section 3.

"**Reference Reach Waters**" are streams representative of a large number of similar streams within a definable geographic area. Reference reach waters are the least impacted within an ecoregion and provide an estimate of attainable conditions for similar streams within the same ecoregion and watershed. These streams are included in the list of exceptional waters in 401 KAR 5:030, Section 3(2).

SPECIAL REPORT

This year could be the driest on record in many states, prompting officials to call for water restrictions for residents and businesses alike. Of course, water conservation makes sense for environmental and economic reasons even if your area is not facing a water shortage.

Below, we've listed 50 ways to live with less water. Most can be done for little or no cost. Keep in mind that making just one or two changes can make a major difference. Fixing leaky toilets, for instance, can save more than 100 gallons of water a day.



KITCHEN AND LAUNDRY

No- or low-cost actions

Illustrations by Bryon Thompson

- Run the dishwasher and the washing machine only when they are full.

- Don't prerinse dishes before loading the dishwasher. You'll save as much as 20 gallons a load, or 6,500 gallons per year. Our tests show prerinsing doesn't improve cleaning. Or, use the rinse-and-hold dishwasher feature for a less-than-full load before later in the week running the full load. The rinse-and-hold option uses about 2 gallons of water.

- When your dish load is small, fill the sink or basin and wash dishes by hand. Place soapy dishes on a rack, and spray rinse.

- Wash vegetables and fruits in a bowl or basin using a vegetable brush; don't let the water run.

- Use recycled water on plants. Sources: water left from boiled eggs, tea kettles, and washed vegetables; dehumidifier condensate.

- Investigate using waste water from the washing machine, bathtub, or sink on outdoor, inedible plants. States vary in their approach to so-called gray-water use. New York, for example, bans it out of concern that the byproducts of cleaning, say, can contaminate soil. Check with your state or municipality's department of environmental protection for details. (We don't recommend using gray water to wash the car; small particles in the water may scratch the paint.)

- Steam vegetables instead of boiling. Besides using less water, you'll retain more vitamins in the food.

- Chill drinking water in the refrigerator instead of running the faucet until the water is cold.

- Defrost food in the refrigerator, not in a pan of water on the counter or in the sink. Besides saving water, it's less likely to breed bacteria.

Long-term investments

- Make your next dishwasher a water-saver. The most water-efficient models we've tested use only about 5 gallons per wash--less than half that of the least water-efficient models (see our May 2002 dishwasher report, available to subscribers only).

Make your next clothes washer a water-saver. The most water-efficient we've tested, the front-loading *Kenmore* (Sears) *Elite HE 3t,* uses only about 30 gallons for a large, 20-pound wash load, about the same amount that many machines use for an 8-pound load. (Look for a July 2002 report on washers.)

BATHROOM

No- or low-cost actions

Fix toilet leaks. Plumbing leaks as a whole account for 14 percent of water consumed in the home, according to a study sponsored by the American Water Works Association, an industry trade group. One cause is toilet leaks, which often go unnoticed. To determine whether your older toilet is leaking, add food coloring to the tank water and let it sit 15 minutes. If it appears in the bowl, there's a leak.

Don't use your toilet as a wastebasket.

Turn off the faucet when brushing teeth. Faucets can spout 2 to 3 gallons per minute.

Time your showers to keep them short; this can cut 5 to 7 gallons per minute with an old-style showerhead. Or turn off the water while lathering.

Displace some water in the toilet tank of an older toilet with a capped plastic liter bottle filled with water.

Also for older toilets: Consider installing an early-closing flapper valve, which prevents a part of the tank from emptying.

When taking a bath, close the drain before turning on the water. And fill it half as full as you usually do; you could save 10 to 15 gallons.

Install new showerheads and low-flow faucets. Showerheads that were made after January 1994 must use no more than 2 1/2 gallons per minute (see our May 1998 remodeling report, available to subscribers only).

Long-term investments

Replace older toilets with low-flow models. Some of them work very well, and they use less than half as much water as older models (see our May 1998 remodeling report, available to subscribers only). We'll report on low-flow toilets this fall.

Insulate your water heater and all hot-water pipes so you waste less while waiting for the hot water to flow.

LAWN, PATIO, DRIVEWAY

No- or low-cost actions

Fix leaky hoses and hose connections.

Outfit all hoses with automatic shutoff (pistol-style) nozzles.

Adjust hose attachments and sprinkler heads to emit large drops instead of fine spray, which evaporates more easily.

Use a sprinkler timer, but don't overwater. Your local Department of Agriculture Cooperative Extension office can advise on what's appropriate for your region. (For a listing of offices throughout the country, go to www.reeusda.gov/statepartners/usa.htm.)

- Position sprinklers so they're not watering driveways and walkways.

- Hand-water with a hose where possible. Homeowners who water with a handheld hose can use one-third less water outdoors than those who use automatic sprinklers.

- Water during the coolest time of the day to reduce evaporation. Don't water when it's windy.

- Adjust your lawnmower to cut grass to a height of 3 inches or more. Taller grass encourages deeper roots and shades the soil to reduce moisture loss.

- If faced with watering restrictions, concentrate first on shrubs and trees, then perennials, then annuals. Unless your lawn is newly planted, let it grow brown; it will likely perk up as the weather cools.

- Sweep driveways, sidewalks, and steps instead of hosing them down.

GARDEN

No- or low-cost actions

- Add compost or peat moss to soil to improve its water-holding capacity.

- Mulch beds to a depth of 2 to 3 inches to reduce evaporation.

- To ensure that potted plants and flowers use water most efficiently, consider adding polymer crystals to soil in flowerpots to make it more absorbent, or buy special patio pots that allow water to reach roots efficiently. Such products are available at garden retailers.

- Choose drought-tolerant plants. Perennials include coneflower, butterfly weed, goldenrod, iris, and daylily. Annuals include verbena, dianthus, and cosmos. Herbs include thyme, rosemary, lavender, aloe, and many species of salvia. As for shrubs, conifers generally use less water in the summer than flowering shrubs. Trees include Japanese pagoda, Kentucky coffee, honey locust, and Eastern red cedar.

- Put off planting major shrubs. Even drought-tolerant varieties need a season or more of intensive watering to properly develop root systems.

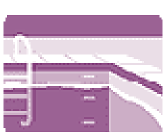
- Reduce the size of your vegetable garden. Plant tomatoes and herbs in pots and use recycled water on them.

- Consider buying a rain barrel to catch water from your gutter system to use on plants. A barrel that holds about 60 gallons--and includes a childproof lid--costs about $100. Most have a spigot for easy dispensing on your plants.

Long-term investments

- Consider drip irrigation for flowers and shrubs. These systems, which can be purchased at home-improvement and garden retailers, are lengths of thin plastic tubing perforated at intervals and placed at the base of plants where the water can most efficiently penetrate to the roots.

- Develop a long-term landscaping plan that uses drought-tolerant plants. Wise landscaping can save up to 50 percent of the water you use outdoors. Change the composition of your lawn to drought-tolerant strains.



RECREATION

No- or low-cost actions

- If you're allowed to fill your pool, use a cover to reduce evaporation.

- Fill pool a few inches lower than usual.

- Avoid water toys that need a constant stream of water.

Water Parameters

From USGS Water Science for Schools

Water temperature

Water temperature is not only important to swimmers and fisherman, but also to industries and even fish and algae. A lot of water is used for cooling purposes in power plants that generate electricity. They need cool water to start with, and they generally release warmer water back to the environment. The temperature of the released water can affect downstream habitats. Temperature also can affect the ability of water to hold oxygen as well as the ability of organisms to resist certain pollutants.

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pH

pH is a measure of how acidic/basic water is. The range goes from 0 - 14, with 7 being neutral. pHs of less than 7 indicate acidity, whereas a pH of greater than 7 indicates a base. pH is really a measure of the relative amount of free hydrogen and hydroxyl ions in the water. Water that has more free hydrogen ions is acidic, whereas water that has more free hydroxyl ions is basic. Since pH can be affected by chemicals in the water, pH is an important indicator of water that is changing chemically. pH is reported in "logarithmic units," like the Richter scale, which measures earthquakes. Each number represents a 10-fold change in the acidity/baseness of the water. Water with a pH of 5 is ten times more acidic than water having a pH of six.

Pollution can change water's pH, which in turn can harm animals and plants living in the water. For instance, water coming out of an abandoned coalmine can have a pH of 2, which is very acidic and would definitely affect any fish crazy enough to try to live in it! By using the logarithm scale, this mine-drainage water would be 100,000 times more acidic than neutral water -- so stay out of abandoned mines.

Specific conductance

Specific conductance is a measure of the ability of water to conduct an electrical current. It is highly dependent on the amount of dissolved solids (such as salt) in the water. Pure water, such as distilled water, will have a very low specific conductance, and seawater will have a high specific conductance. Rainwater often dissolves airborne gasses and airborne dust while it is in the air, and thus often has a higher specific conductance than distilled water. Specific conductance is an important water-quality measurement because it gives a good idea of the amount of dissolved material in the water.

Probably in school you've done the experiment where you hook up a battery to a light bulb and run two wires from the battery into a beaker of water. When the wires are put into a beaker of distilled water, the light will not light. But, the bulb does light up when the beaker contains salt water (saline). In the saline water, the salt has dissolved, releasing free electrons, and the water will conduct an electrical current.

Turbidity

Turbidity is the amount of particulate matter that is suspended in water. Turbidity measures the scattering effect that suspended solids have on light: the higher the intensity of scattered light, the higher the turbidity. Material that causes water to be turbid include:

- clay
- silt
- finely divided organic and inorganic matter
- soluble colored organic compounds
- plankton
- microscopic organisms

Turbidity makes the water cloudy or opaque. Turbidity is measured by shining a light through the water and is reported in nephelometric turbidity units (NTU). During periods of low flow (base flow), many rivers are a clear green color, and turbidities are low, usually less than 10 NTU. During a rainstorm, particles from the surrounding land are washed into the river making the water a muddy brown color, indicating water that has higher turbidity values. Also, during high flows, water velocities are faster and water volumes are higher, which can more easily stir up and suspend material from the stream bed, causing higher turbidities.

Turbidity can be measured in the laboratory and also on-site in the river. A handheld turbidity meter measures turbidity of a water sample. The meter is calibrated using standard samples from the meter manufacturer. The picture with the three glass vials shows turbidity standards of 5, 50, and 500 NTUs. Once the meter is calibrated to correctly read these standards, the turbidity of a water sample can be taken. State-of-the-art turbidity meters are beginning to be installed in rivers to provide an instantaneous turbidity reading. It reads turbidity in the river by shining a light into the water and reading how much light is reflected back to the sensor. The smaller tube contains a conductivity sensor to measure electrical conductance of the water, which is strongly influenced by dissolved solids and a temperature gauge.

Dissolved oxygen

Although water molecules contain an oxygen atom, this oxygen is not what is needed by aquatic organisms living in our natural waters. A small amount of oxygen, up to about ten molecules of oxygen per million of water, is actually dissolved in water. This dissolved oxygen is breathed by fish and zooplankton and is needed by them to survive.

Rapidly moving water, such as in a mountain stream or large river, tends to contain a lot of dissolved oxygen, while stagnant water contains little. Bacteria in water can consume oxygen as organic matter decays. Thus, excess organic material in our lakes and rivers can cause an oxygen-deficient situation to occur. Aquatic life can have a hard time in stagnant water that has a lot of rotting, organic material in it, especially in summer, when dissolved-oxygen levels are at a seasonal low.

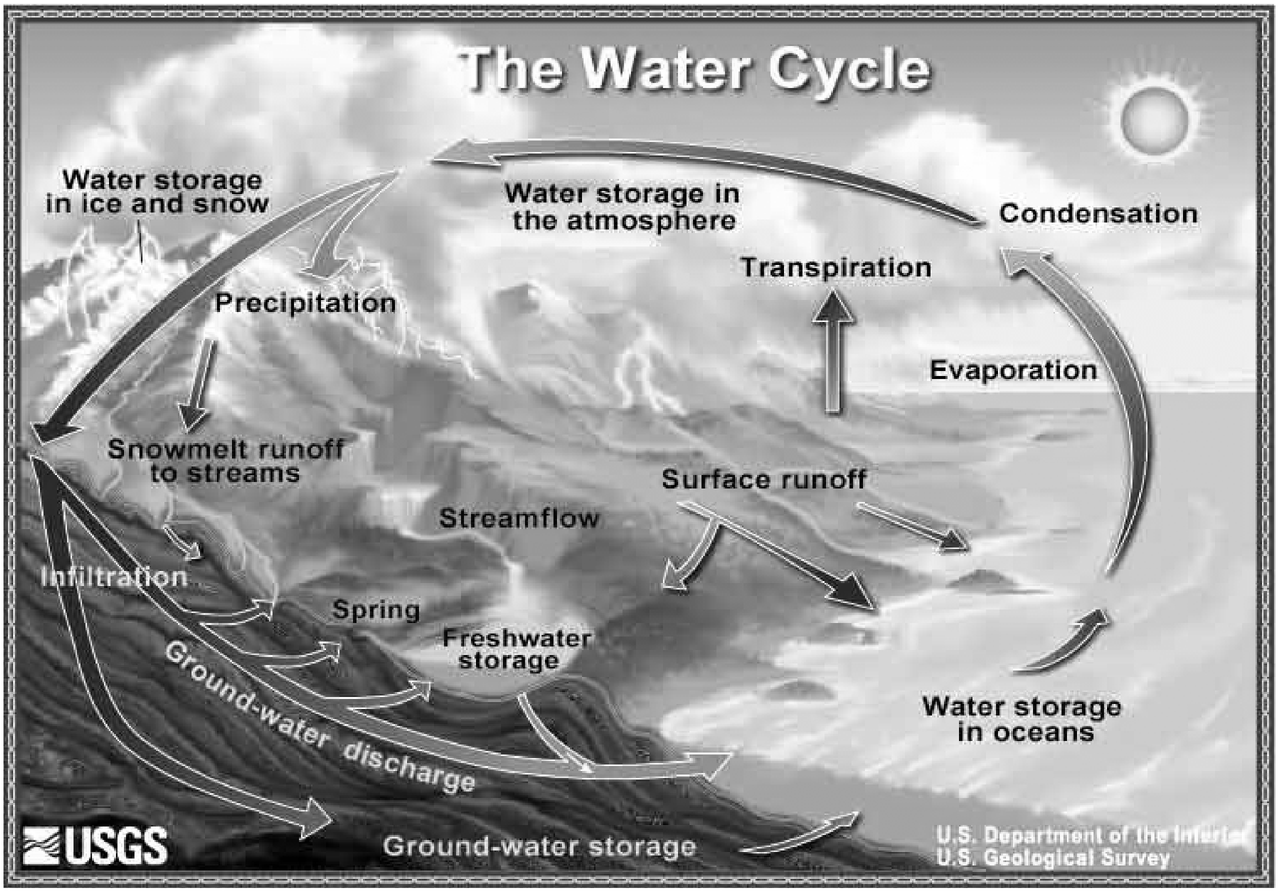
Hardness

The amount of dissolved calcium and magnesium in water determines its "hardness." Water hardness varies throughout the United States. If you live in an area where the water is "soft," then you may never have even heard of water hardness. But, if you live in Florida, New Mexico, Arizona, Utah, Wyoming, Nebraska, South Dakota, Iowa, Wisconsin, or Indiana, where the water is relatively hard, you may notice that it is difficult to get a lather up when washing your hands or clothes. And, industries in your area might have to spend money to soften their water, as hard water can damage equipment. Hard water can even shorten the life of fabrics and clothes! Does this mean that students who live in areas with hard water keep up with the latest fashions since their clothes wear out faster?

Suspended sediment

Suspended sediment is the amount of soil moving along in a stream. It is highly dependent on the speed of the water flow, as fast-flowing water can pick up and suspend more soil than calm water. During storms, soil is washed from the stream banks into the stream. The amount that washes into a stream depends on the type of land in the river's drainage basin and the vegetation surrounding the river.
If land is disturbed along a stream and protection measures are not taken, then excess sediment can harm the water quality of a stream. You've probably seen those short, plastic fences that builders put up on the edges of the property they are developing. These silt fences are supposed to trap sediment during a rainstorm and keep it from washing into a stream, as excess sediment can harm the creeks, rivers, lakes, and reservoirs.

Sediment coming into a reservoir is always a concern; once it enters it cannot get out - most of it will settle to the bottom. Reservoirs can "silt in" if too much sediment enters them. The volume of the reservoir is reduced, resulting in less area for boating, fishing, and recreation, as well as reducing the power-generation capability of the power plant in the dam.



An Overview of Kentucky's Waters – 2002

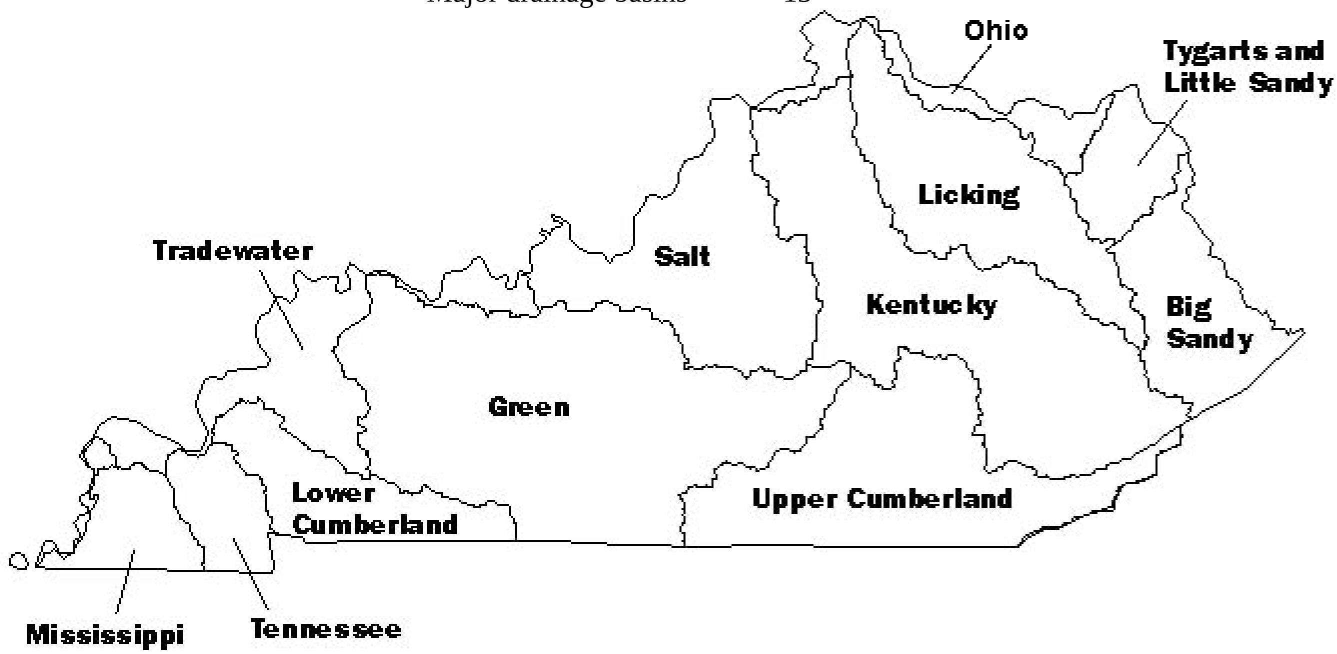
From KY Division of Water Homepage

WATER RESOURCES

Average annual rainfall	40 - 50 inches
Maximum	winter and spring
Minimum	late summer and fall

WHERE THE WATER OCCURS

State surface area	40,409
Major drainage basins	13



On the surface

Miles of rivers and streams	89,431
Miles of rivers bordering other states	849
Acres of wetlands	637,000
Number of reservoirs more than 1,000 acres in size	18
Acres of publicly owned lakes and reservoirs	228,385

Under the ground

Percent of Kentucky land underlain by karst topography	55
Percent of rural Kentucky population that is self-supplied who rely on groundwater	90
Number of private *domestic* water wells installed since July 1985	21,000
Number of public water supplies that depend on groundwater	283
Population served by public systems supplied by groundwater	618,000

Links of Interest

Wetlands Info	www.nwi.fws.gov/bha
Water Watch Bug Key	kywater.org/ww/bugs/intro.htm
Kentucky Division of Water	www.water.ky.gov
Canon Envirothon	www.envirothon.org
Virginia Envirothon Sample Questions	www.vaswcd.org/envlearning.htm
Tennessee Aquatics Guide	www.appalachianrcd.org/tnrcd/Envirothon/resources.htm
Water Cycle Explanation and Illustration	www.waterknowledge.colostate.edu/hydr_cyc.htm
Groundwater Foundation	www.groundwater.org
Water Cycle	ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/hyd/home.rxml
Drinking and Ground Water	www.epa.gov/safewater/kids/cycle.html
Water Cycle	ga.water.usgs.gov/edu/watercycle.html
Water Basics	ga.water.usgs.gov/edu/mwater.html
Wetlands	www.epa.gov/owow/wetlands
Kentucky Water Overview	www.water.ky.gov/homepage_repository/overview.htm
Kentucky Water Laws	www.water.ky.gov/statutes/
EPA Student Center for Water	www.epa.gov/students/water.htm
Environment Canada the Hydrologic Cycle.	www.ec.gc.ca/water/en/info/pubs/lntwfg/e_chap1b.htm
USGS physical & chemical properties of water	ga.water.usgs.gov/edu/waterproperties.html
Water Use USA	ga.water.usgs.gov/edu/wateruse.html
Water Conservation USA	www.epa.gov/watrhome/you/intro.html
USA Water Pollution	www.epa.gov/ebtpages/watewaterpollution.html
Benthic Macro-invertebrates in Our Water	www.epa.gov/bioindicators/html/benthosclean.html
Watersheds	www.gov/owow/watershed/whatis.html
Locate Your Watershed	cfpub.epa.gov/surf/locate/index.cfm
Globe Hydrology	www.globe.gov/sda/tg/globetg.html
Groundwater Aquifers	ga.water.usgs.gov/edu/earthgwaquifer.html
Wetlands	www.on.ec.gc.ca/wildlife/wetlands/aboutwetlands-e.cfm
Riparian Benefits	www.on.ec.gc.ca/wildlife/factsheets/fs_habitat-e.html#riparian
Aquatic Ecosystem Perspective	www.ec.gc.ca/water/en/info/pubs/primer/e_prim05.htm#a2
Common Water Measurements	ga.water.usgs.gov/edu/characteristics.html
Clean Water Act	www.epa.gov/r5water/cwa.htm
Water on the Web	waterontheweb.org
Ohio Watershed Network	ohiowatershedds.osu.edu/library/2.html
World Resources Institute	earthtrends.wri.org/searchable_db/index.php?theme=2